The Dynamics of Strategic Alliances

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Introduction

A strategic alliance is defined as a business relationship among autonomous firms that might otherwise stand in rivalry. Moreover, a strategic alliance is characterized by the fact that high performance can be achieved through long-term collaboration (Ushimaru 2002). Since organizational learning takes place quickly, strategic alliances are regarded as superior to mergers and acquisitions (M&A) in a context of great environmental uncertainty (Ushimaru 2000).

However, the strategic alliance is distinguished by its instability and by its high probability of dissolution in the short term (Ushimaru 2001). More specifically, it is difficult to form a relationship between two firms that offers advantages to both sides; moreover, if one side betrays the other, then only one side will derive an advantage. However, M&A involve an integration of the complex systems of both partners and are very costly, so a relationship created in this way, following M&A, is almost never dissolved. In contrast, strategic alliances require less integration than do M&A, and are very easily dissolved as a result.

The fact that a strategic alliance is unstable brings with it the critical question of how a firm should be managed, following the establishment of an alliance, so that the relationship may be maintained.

This study has two goals. The first is the development of a new analytic framework. This framework is based on game theory and characterizes the maintenance of strategic alliances. The second goal is the simulation of the analytic model. This simulation is based on system dynamics and characterizes how the constituent elements of strategic alliances behave. The effectiveness of

this approach as an analytic tool is also examined.

Analytic Framework

Structural Cooperation and Motivational Cooperation

One source of instability in a strategic alliance arises because a partner relationship necessarily involves a situation analogous to the "prisoner's dilemma". In the "prisoner's dilemma" involving a cooperative relationship, betrayal or deviation yields a greater payoff than does cooperation for each firm; therefore, both firms choose betrayal and, as a result, the payoff for each is low. Two conceivable ways of maintaining a strategic alliance exist, namely, the "structural cooperation approach" and the "motivational cooperation approach" (Zeng and Chen 2003).

The "structural cooperation approach" attempts to resolve the dilemma by changing the payoff structure of the game. Put simply, "changing the payoff structure" means applying some penalty to a player who chooses to deviate. Adding a penalty provides an incentive to choose cooperation. In this sense, such methods attempt to maintain a cooperative relationship through the adoption of a penalty system. For this reason, we call methods that change the payoff structure "structural cooperation." Thus, structural cooperation becomes effective when partners behave opportunistically.

The "motivational cooperation approach" attempts to resolve the dilemma intrinsically, or voluntarily, without using any structural means. Motivational cooperation becomes effective when the game is repeated infinitely, as well as when the expected payoff is sufficiently high. First, in a finitely repeated game, betrayal is optimal for each player, even if the game is played a thousand times. Even if a cooperative relationship continues until the 999-th trial, betrayal is preferred by each player in the final trial, because there is no need to consider the future. Since it is known that deviation will occur in the final trial, the best strategy is deviation from the beginning to the end, whenever the number of trials is finite. Therefore, in the finitely repeated case, both players choose to deviate, and no cooperative relationship arises. However, in the infinitely repeated case, it is beneficial for both sides to select a cooperative strategy if certain conditions are fulfilled. This fact is generally known as the "Folk Theorem". The Folk Theorem also makes clear that, if the expected future payoff is sufficiently high, it is more advantageous to select a cooperative strategy than to deviate via betrayal.

Note, however, that structural cooperation carries with it the additional problem of a secondary dilemma (Yamamoto 1997). That is, even if penalties for betrayal are adopted as an institution, there is no guarantee that all parties to the alliance will comply with it. Rather, it becomes necessary to monitor compliance and to put the penalty system into effect in the case of noncompliance. These activities naturally require some expense. Moreover, if the expense resulting from the implementation of the penalty system exceeds the amount of the additional gain generated by cooperation, it becomes meaningless to create such a system and impose regulations such as monitoring and penalty enforcement. In practice, it is not possible to monitor a business partner accurately. Therefore, it is difficult to maintain a cooperative relationship through structural cooperation. For example, Ushimaru (2003) examined empirically which approach (structural cooperation or motivational cooperation) was more effective in the maintenance of a strategic alliance, and found that motivational cooperation is typically more effective.

A trade-off between structural cooperation and motivational cooperation is commonly supposed to exist. According to intrinsic motivation theory, if a player is continually given some reward from the outside for actions he performs voluntarily, the intrinsic/voluntary motivation for that behavior will weaken and, in the end, the player will be motivated only by the external reward (Deci 1975). According to this theory, motivational cooperation should cease when it reaches the point where the strategic alliance is managed through structural cooperation. That is, as penalties have an increasingly strong impact in maintaining the strategic alliance, the impact of the expected future payoff on relationship maintenance weakens. However, intrinsic motivation theory assumes that a one-way relationship exists (i.e., there is a single giver of a reward and a single receiver of the reward), and that the receiver is passive. The actual cooperative relationship is bidirectional and active, however, with both partners building the reward/penalty structure. Therefore, it can be easily imagined that motivational cooperation may weaken structural cooperation. In this regard, Ushimaru (2003) conducted an empirical study into which approach proved more effective in maintaining a strategic alliance, and reported the existence of a trade-off relationship between structural cooperation and motivational cooperation.

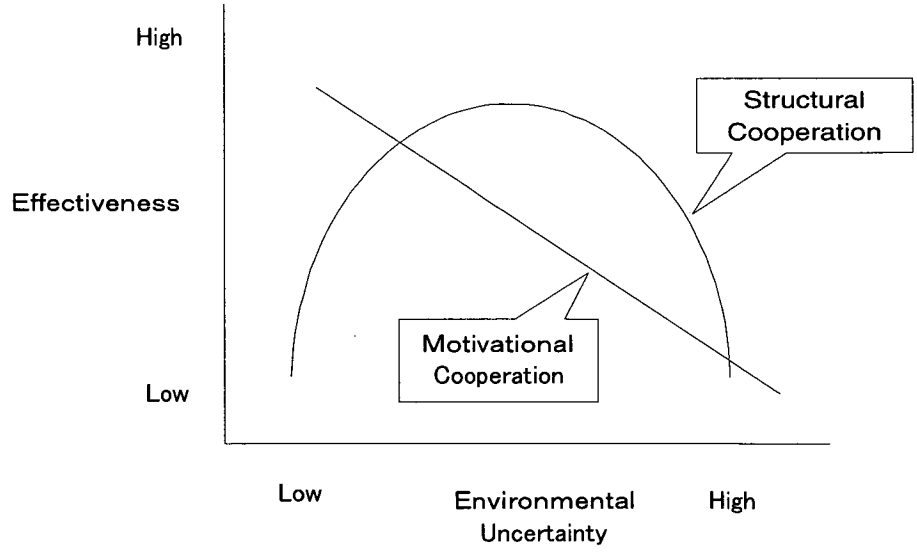
Environmental Uncertainty

Environmental uncertainty is not considered in the above discussion about the maintenance of a strategic alliance. The above discussion assumes that the strategy taken by each player is

accurately communicated, and that it is also possible for each player to foretell his future expected payoff accurately. However, in reality, the environment is uncertain. Thus, it is unclear to each player what strategy the other player will adopt, and it is also difficult for each player to predict his expected future payoff accurately. Therefore, even though motivational cooperation is effective in a certain environment, structural cooperation may be more effective for the management of a strategic alliance in an uncertain environment.

First, note that the effectiveness of motivational cooperation decreases as uncertainty increases. This decline occurs because uncertainty reduces expected payoffs, which drive motivational cooperation, and because infinitely repeated transactions become uncertain in this context. As a result, it is not clear what kind of performance can be obtained in the future through cooperation. Predictions of how long the cooperative relationship will continue are also rendered useless. Therefore, as environmental uncertainty increases, the effectiveness of motivational cooperation decreases.

Next, note further that, under structural cooperation, it is conceivable that, in an uncertain environment, methods of cooperative enforcement, such as severe penalties for deviation, might be employed in order to suppress opportunistic behavior on the part of a business partner. However, if uncertainty increases too much, then the monitoring cost increases and the



Note Ushimaru (2005)

Figure 1. Relationship between Environmental Uncertainty and the Effectiveness of Cooperation

secondary dilemma mentioned above arises. Therefore, it is thought that the effectiveness of structural cooperation tends to increase as uncertainty increases, but decreases after a certain point (Fig. 1).

Trust

Numerous studies have acknowledged that trust formation is crucial for maintaining strategic alliances. For example, Child and Faulkner (1998) have pointed out that trust is crucial for the success of alliances (joint ventures). Also, research by Beamish (1988), Harrigan (1986), and others has clarified empirically that trust between joint-venture partners is crucial for the maintenance of long-term relationships.

"Trust" is defined as "the expectation that the other party will behave cooperatively towards one's self in a situation where there is potential for one's self to suffer losses if the other party behaves selfishly. (i.e., a situation where social uncertainty exists)" (Yamagishi 1998). Trust may be classified according to the following four types: deterrence-based trust, calculus-based trust, relational trust, and institution-based trust.

Deterrence-based trust occurs when a partner is trusted because he will incur a large loss in the case of betrayal. Calculus-based trust occurs when a partner is trusted because he expects to receive a large benefit in the future as a result of his cooperation. In the contexts of these two types of trust, it is difficult to calculate the changes in the gains or losses that occur as uncertainty increases; thus, these concepts differ from a concept of "trust" whereby the partners cooperate, even if they find themselves in an uncertain situation. On the other hand, relational trust is trust formed through bidirectional, long-term, and recurrent interaction. The extent of the past trust or dependence relationship that has been built up between partners creates positive expectations in both partners of each other. As this sort of relational trust continues, an emotional relationship is formed in both directions, and this added bond results in citizenship behavior, such as mutual loyalty and wide-ranging support. Finally, institution-based trust is trust based on a legal system that protects rights and assets and forms the backdrop for the relationship; in particular, the extent to which the partner is trusted varies depending on whether or not the relationship occurs in a society where such a legal system is effective. Institution-based trust is regarded as the foundation for calculus-based trust and relational trust, as it must exist prior to their development. These two types of trust involve the trusting of a partner in the absence of uncertainty, and can be thought of as original concepts of trust.

The above considerations indicate that there are really only two distinct types of trust,

namely institution-based trust, which exists prior to the formation of a relationship with a partner, and relational trust, which is formed after the fact. During the initial phase of relationship formation, institution-based trust plays a large role in the stability of strategic alliances under conditions of high uncertainty. It is thought that relational trust plays a larger role as a relationship becomes long term.

System Dynamics

System dynamics is a technique for simulating the behavior of complex social systems and was originally an application of automatic control theory (adopted from engineering fields) to issues in the social sciences. Under system dynamics, the simulation of system behavior is carried out in order to elucidate a certain phenomenon in a complex social system; this task is accomplished by using a simplified system created by selecting the things thought to be key factors driving the phenomenon, and by clarifying the causal relationship of these factors.

One distinguishing feature of system dynamics is that it facilitates learning about dynamic systems that vary over time. Note that time discrepancies exist in the relationships among factors in real-world systems, as well as differences in the speed of effects. Another distinguishing feature is that system dynamics facilitates learning about complex systems that incorporate feedback. This feature is useful because the relationships among factors in real-world systems are typically not one way.

More technically, complex time-series systems are modeled using simultaneous difference equations or simultaneous ordinary differential equations, and problems are solved by supplying initial values for those equations.

The discussion "Limits to Growth" by the Club of Rome (Meadows et al. 1972) is an example of research based on system dynamics. However, at the time it was written, it was not possible to solve complex problems requiring numerical calculation without the aid of computers; therefore, the techniques used generally did not disseminate into the business world. However, during the 1990s, which saw an increase in the sophistication and miniaturization of computer technology, as well as the development of STELLA, Powersim, and other software packages, these techniques became practical for researchers in the field of business studies and the social sciences. In the field of business studies, these methods were adopted as a problem-solving tool for formulating strategies, tactics, and management approaches. Attempts have even been made to use these

techniques to balance scorecards. In the area of management research, these techniques have been treated by Senge (1990) as a business conceptualization method called "systems thinking." Therefore, in some sense, we can say that system dynamics is both an old and a new technique.

Simulation

Causal Relationship Model for the Stability of a Strategic Alliance

Figure 2 illustrates a causal relationship model of the factors that affect the stability of a strategic alliance. The model comprises three reinforcement loops (R1, R2, R3), one balance loop (B1), and one exogenous variable (institution-based trust).

Loop R1

This reinforcement loop comprises environmental uncertainty, expected payoffs, motivational cooperation, the stability of the strategic alliance, and relational trust.

If institution-based trust (the exogenous variable) is high, then environmental uncertainty decreases. As environmental uncertainty decreases, the expected payoffs increase. As the expected payoffs increase, motivational cooperation increases. When motivational cooperation increases, the stability of the strategic alliance increases. As the stability of the strategic alliance increases, relational trust increases. As relational trust increases, environmental uncertainty decreases. Moreover, the stability of the strategic alliance is reinforced through the repetition of this cycle.

In contrast, if institution-based trust is low, then environmental uncertainty increases. As environmental uncertainty rises, the expected payoffs decrease. As the expected payoffs decrease, motivational cooperation decreases. As motivational cooperation decreases, the stability of the strategic alliance increases. As the stability of the strategic alliance increases, relational trust decreases. As relational trust decreases, environmental uncertainty increases. In addition, the instability of the strategic alliance is reinforced through the repetition of this cycle.

Loop R2

This reinforcement loop comprises environmental uncertainty, the cost of monitoring, structural cooperation, the stability of the strategic alliance, and relational trust.

If institution-based trust (the exogenous variable) is high, then environmental uncertainty

decreases. As environmental uncertainty decreases, the monitoring cost decreases. As the monitoring cost decreases, structural cooperation increases. As structural cooperation increases, the stability of the strategic alliance increases. As the stability of the strategic alliance increases, relational trust increases. As relational trust increases, environmental uncertainty decreases. The stability of the strategic alliance is reinforced through the repetition of this cycle.

If institution-based trust is low, then environmental uncertainty increases. As environmental uncertainty increases, the monitoring cost increases. As the monitoring cost increases, structural cooperation decreases. As structural cooperation decreases, the stability of the strategic alliance decreases. As the stability of the strategic alliance decreases, relational trust decreases. As relational trust decreases, environmental uncertainty increases. The instability of the strategic alliance is reinforced through the repetition of this cycle.

Loop B1

This balance loop comprises environmental uncertainty, opportunistic behavior, structural cooperation, the stability of the strategic alliance, and relational trust.

If institution-based trust (the exogenous variable) is high, then environmental uncertainty decreases. As environmental uncertainty decreases, opportunistic behavior decreases. As opportunistic behavior decreases, structural cooperation decreases. As structural cooperation decreases, the stability of the strategic alliance decreases. As the stability of the strategic alliance decreases, relational trust decreases. As relational trust decreases, environmental uncertainty increases. As environmental uncertainty increases, opportunistic behavior increases. As opportunistic behavior increases, structural cooperation increases. As structural cooperation increases, the stability of the strategic alliance increases. As the stability of the strategic alliance increases, relational trust increases. As relational trust increases, environmental uncertainty decreases. In this case, therefore, the stability status of the strategic alliance becomes unstable, sometimes increasing and sometimes decreasing, through the repetition of this cycle.

If institution-based trust is low, the situation is the same as if it were high; that is, the strategic alliance repeatedly cycles through phases of increasing and decreasing stability.

Loop R3

This reinforcement loop comprises motivational cooperation and structural cooperation. There is a trade-off between these two types of cooperation, and thus, as motivational cooperation

increases, structural cooperation decreases. Similarly, as structural cooperation decreases, motivational cooperation increases. This reinforcement cycle is repeated.

The stability of the strategic alliance results from the interaction of the above three loops. Furthermore, the relationships among the variables evolve with a time lag. For this reason, it is extremely difficult to predict stability. Computer simulations using system dynamics are an effective tool for predicting the outcomes of such time-oriented, complex behavior.

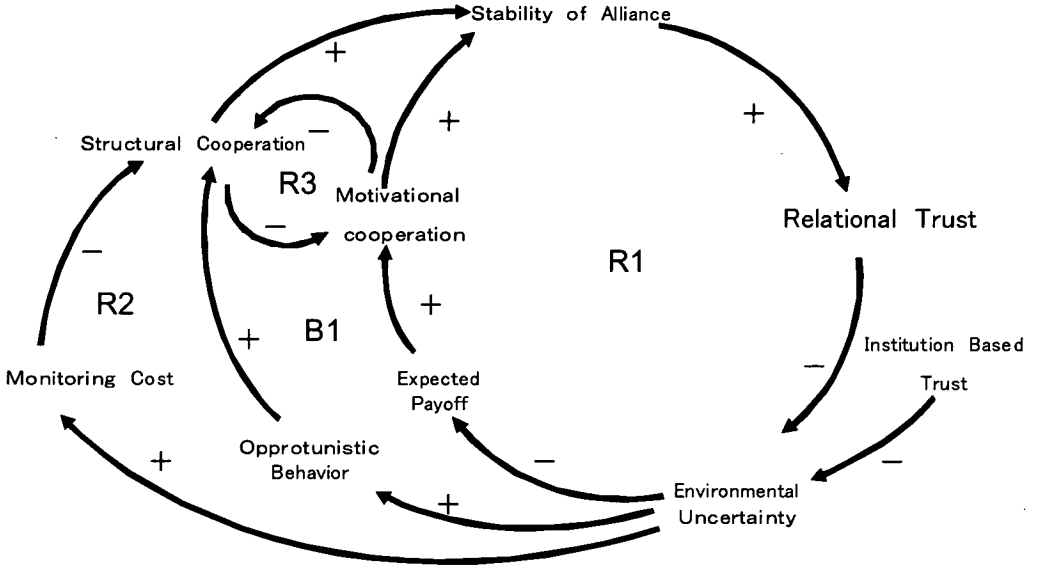


Figure2. Causal Relationship Model Regarding the Stability of Strategic Alliance

Simulation Model and Operation

Figure 3 illustrates the simulation model using STELLA (software for simulating system dynamics). The adopted simulation model is qualitative, not quantitative. The numerical values chosen are all fictitious. Building a more complex model incorporating delay effects or complementary variables lowers the explanatory power of the model. Therefore, the model used for this analysis is simple.

The model comprises three features: stocks, flows, and connectors. A stock is a variable that accumulates value as time passes. A flow is a variable that causes a stock to increase or decrease as time passes. A connector indicates the causal direction between variables. There are eight stock variables in the model: the stability of the strategic alliance, motivational cooperation,

structural cooperation, the expected payoffs, trust, environmental uncertainty, opportunistic behavior, and the monitoring cost. There are also eight flow variables in the model, which include the changes in motivational cooperation, structural cooperation, the expected payoffs, trust, environmental uncertainty, opportunistic behavior, and the monitoring cost.

One problem with the model, as formulated, is that all the numerical values used are fictitious; this fact makes it more likely that the measured results will be large. To resolve this potential problem, it is necessary to prevent the numerical stock values from inflating by restricting all of the numerical flow values to fall within a certain constant range. Therefore, the original data are first transformed using a probit. Then, 0.5 is subtracted from them; this value ensures that all of the original data remain within the range from −0.5 to 0.5. Thus, if an original datum is equal to zero, the transformed datum is still equal to zero. However, the greater the original datum is relative to zero, the closer the transformed datum comes to 0.5. Similarly, the smaller the original datum is relative to zero, the closer the transformed datum comes to −0.5.

$$EXP(original\ data)/(EXP(original\ data)+1))-0.5 \qquad (Formula\ 1)$$

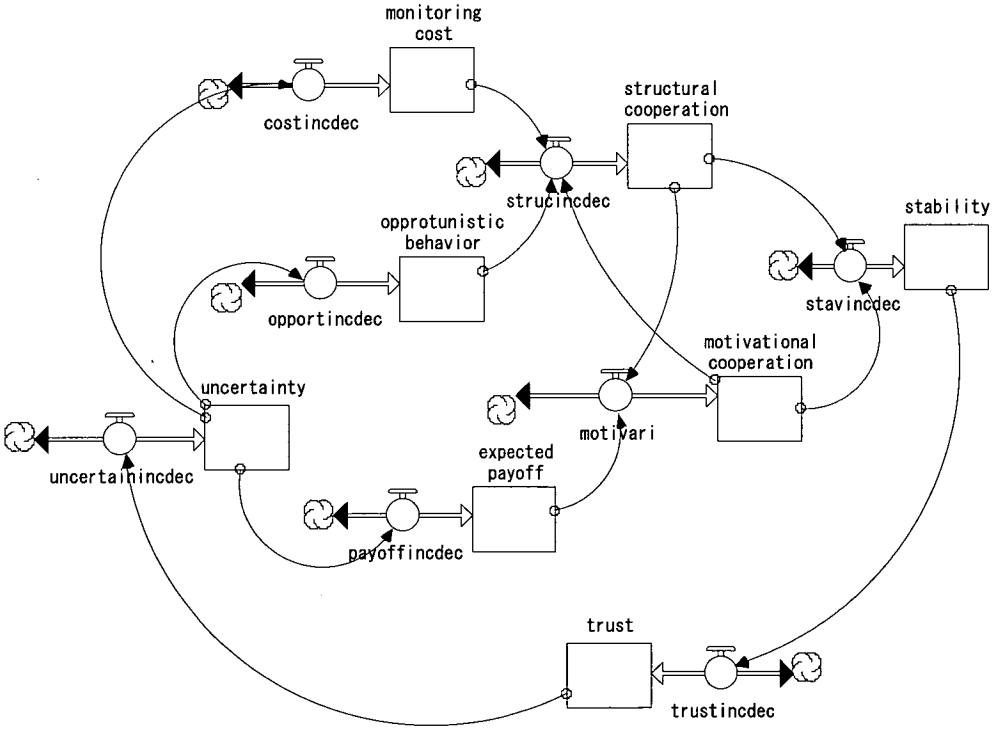


Figure3. Simulation Model

Results

The aim of the study was, primarily, to examine the impact of environmental uncertainty and trust on the stability of a strategic alliance, on motivational cooperation, and on structural cooperation, and to observe how this impact changes over time. However, all of the data and coefficients are fictional; therefore, we established the following two patterns, the results of which are the easiest to predict: (1) a high degree of trust and low environmental uncertainty and (2) a low degree of trust and high environmental uncertainty.

The initial values of the variables other than uncertainty and trust are set to zero, which represents the state in which the respective variables are neither high nor low.

Pattern 1: High Trust, Low Uncertainty

We conduct this simulation by setting the initial value for trust at 10 and the initial value for environmental uncertainty at − 10. That the initial value for trust is 10 means, based on Formula 1, that it is, in fact, close to 0.5; thus, institution-based trust is extremely high in this case. Subsequent variations in the trust value indicate variation in relational trust. In addition, that the initial value for uncertainty is − 10 indicates, based on Formula 1, that it is, in fact, close to 0.5; thus, uncertainty is extremely low in this case.

Figure 4 illustrates the simulation results. First, only motivational cooperation (line 3) increases, while structural cooperation (line 2) decreases. This motion reflects the fact that a trade-off exists between motivational cooperation and structural cooperation. The stability of the alliance increases because the increase in motivational cooperation is greater than the decrease in structural cooperation. This result is in accord with the general prediction that cooperation tends to arise more easily in situations where trust between partners is high and the environment is certain.

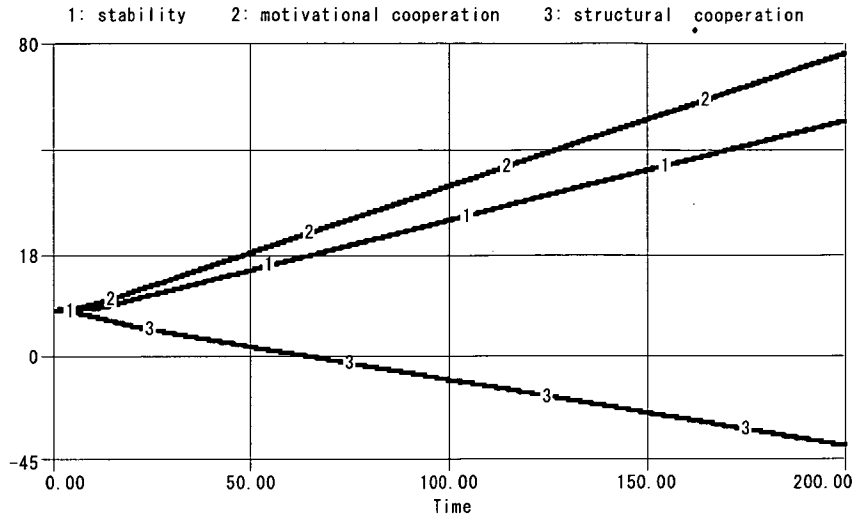


Figure4. High Trust, Low Uncertainty

Pattern 2: Low Trust, High Uncertainty

We conduct this simulation by setting the initial value for trust at -10 and the initial value for environmental uncertainty at 10. That the initial value for trust is -10 means, based on Formula 1, that it is, in fact, close to -0.5; thus, institution-based trust is almost non-existent in this case. In addition, that the initial value for uncertainty is 10 indicates, based on Formula 1, that uncertainty is extremely high.

Figure 5 illustrates the simulation results. First, structural cooperation (line 2) increases until about time 40, at which point it decreases. Then, after a time of about 170 has elapsed, it becomes negative. That is, after time 170, structural cooperation causes instability of the strategic alliance, rather than stability. On the other hand, motivational cooperation (line 3) decreases until about time 40, at which point it increases. After time 170, it becomes positive. That is, after time 170, the stabilization of the strategic alliance is promoted.

However, the stability of the alliance always takes a negative value between time zero and time 210, and is itself extremely unstable. After time 210, it tends to increase with increases in motivational cooperation. In other words, if cooperation has not resolved by time 210, then the cooperative relationship thereafter becomes stable. This variation may occur in part because the maintenance of a long-term relationship leads to the formation of relational trust, a reduction in environmental uncertainty, and an increase in motivational cooperation.

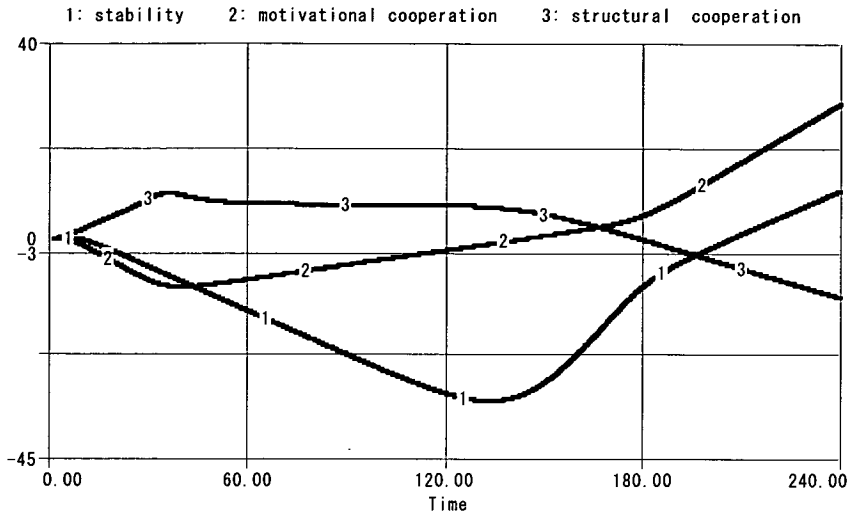


Figure5. Low Trust, High Uncertainty

Conclusion

In this paper, we have considered an analytic framework for the management of strategic alliances over the long term, and have conducted simulations using system dynamics.

First, in this regard, we considered the implications of game theory, which provides a theoretical framework by which to examine the stability of the strategic alliance. Then, based on this theoretical framework, we constructed an analytic model characterizing the stability of the strategic alliance. The key components of this model include motivational cooperation, structural cooperation, opportunistic behavior, a monitoring cost, expected payoffs, environmental uncertainty, and trust. We pointed out that these form a dynamic system involving feedback.

Based on this analytic model, we designed a simulation model using system dynamics. Assuming two patterns, namely high trust with low uncertainty and low trust with high uncertainty, we investigated how the stability of the strategic alliance, structural cooperation, and motivational cooperation behave over time. We found that stability with respect to a strategic alliance can be achieved through motivational cooperation in the case of high trust and low uncertainty. In the case of low trust and high uncertainty, we found that the strategic alliance became extremely unstable. Moreover, when a cooperative relationship is continued in this situation, despite the instability, the possibility exists that it will become stable due to the presence of motivational cooperation.

The contributions of this paper are as follows. First, we have presented an analytic framework relating to the maintenance of a strategic alliance, a topic that has previously not attracted much attention. We have also demonstrated, based on the results of our simulations using system dynamics, that motivational cooperation is an effective means of maintaining the stability of the strategic alliance.

Finally, we should note the following three problems with and limitations of this research. First, the presented analytic model is, in the end, only a basic model, and more detailed variables should have been incorporated. For example, as trust formation factors, it would be useful in future research to consider partner reputation and the existence of past cooperative relationships. Second, our simulations using system dynamics have been based only on fictitious numerical values. A highly practical simulation model could, in the future, be designed after the relationships between variables had been determined, based on a survey and a multivariate analysis of its results. Third, we have not considered the issue of environment recognition. This paper has not incorporated the recognition patterns of companies themselves, which discriminate between environments, or the environmental uncertainty that exists within companies. With regard to the uncertainty of the external environment, it is conceivable that recognition patterns differ across companies. In the future, these points too will need to be addressed.

Acknowledgements

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